Indirect Tax Incidence in Madagascar: Updated Estimates Using the Input-Output Table

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Introduction

Recently, there has been renewed interest in the analysis of tax incidence in Africa (Sahn and Younger, 2003; Chen, Matovu, and Reinnika, 2001; Rajemison and Younger, 2000; Younger, et.al., 1999; Alderman and del Ninno, 1999; Sahn and Younger, 1998). In part, this is motivated by the obvious need for tax reform in Africa, where revenues are small as a share of GDP (outside the economies with large mineral royalties) and the tax system is often highly distortionary, relying excessively on trade taxes and narrow commodity excises. Yet with every reform comes the concern of how a policy change will affect the distribution of income, and in particular, how poorer households will fare.

Madagascar is no exception. Historically, tax-to-GDP ratios have been quite low in Madagscar. Arguably, the main goal of several important changes in tax policy in the 1990s was neither improved efficiency nor better equity, but simply to increase the amount of resources available to the public sector. In this, the reforms succeeded, albeit modestly. From 1995 to 1999, total tax revenue rose from 8.9 percent of GDP to 12.2 percent. To date, no analysis has looked at the equity consequences of Madagascar's tax reforms. The first purpose of this study is to fill that gap.

Our second purpose is to evaluate a new method for assessing the incidence of taxes that fall primarily on intermediate inputs rather than final goods and services. All of the newer literature on tax incidence relies on nationally representative household survey data. Surveys of this type are increasingly available in Africa, and they provide an attractive new source of data. Nevertheless, they have their limits for tax analysis, particularly for taxes on intermediate consumption. With the exception of one previous study (Rajemison and Younger, 2000), existing studies either restrict themselves to taxes on final demand (Alderman and del Ninno, 1999) or make strong assumptions about the incidence of taxes on inputs (Chen, Matovu, and Reinnika, 2001; Younger, et.al., 1999; Sahn and Younger, 1998).

As with our previous work, our aim in this paper is to follow up on the existing tax incidence studies for Madagascar by relaxing their rather strict set of methodological assumptions. In particular, rather than making use of only households' pattern of demand in the analysis, we also employ an input-output (IO) table for Madagascar. This permits us to trace an indirect tax levied on intermediate products through the IO table to final consumers. This approach is particularly important for analysis of import duties and petroleum taxes. Two-thirds of imports to Madagascar are intermediate goods, as is about 80 percent of petroleum consumption. Clearly, taking some account of the indirect impact of taxes on these goods and services is important to understand their incidence. One important improvement in this paper over our earlier study is the use of an IO table with a highly disaggregated petroleum sector.

The main results of the paper compare the tax incidence we find for 1999 with the tax incidence that we found in our earlier study, which used the 1995 IO table and the 1993 EPM expenditure data ((Rajemison and Younger, 2000). We are especially interested in estimating the impact of the major changes in tax policy over this period on the progressivity of taxation in Madagascar. In addition to these results, we also examine the importance of our methodological innovation for the interpretation of tax incidence.

Background – Madagascar's Changing Tax System

Madagascar's fiscal health eroded steadily for nearly two decades, from the late 1970's through the early 1990's. Tax revenues fell nearly in half over that interval, from 13% to 7% of GDP. At the same time, external borrowing surged to finance the government's ambitious "Investir à l'Outrance" policy leaving Madagascar heavily indebted, with debt service levels of roughly 5% of GDP (Dissou et al., 1998). Given widespread tax evasion, poor communications infrastructure, and inefficiencies in the tax collection machinery, effective rates of taxation lay between 40% and 80% of statutory levels in 1995 (deMelo, Roland-Holst, and Haddad, 1993; Dissou et al., 1998).

The new government, which assumed power following the political turbulence of the early 1990's, emerged with a firm commitment to strengthening fiscal health by raising effective rates of taxation and expanding the country's narrow tax base. They created a *Centre Fiscal Pilote des Entreprises* in 1997 to simplify, centralize and improve tax recovery among large businesses. They improved customs controls and instituted a new computerized monitoring system, SYDONIA, as well as a new system for managing Zone Franche controls.

As a result of these reforms, Madagascar's tax system has undergone significant change since the early 1990's. Nominal tax rates have changed, with increases in some, such as excise tax rates, and a reduction in others, such as the TVA, which has fallen from 25% to 20%. More importantly, effective rates of tax collection have grown. Overall tax revenues increased by one-third, from 8.9% of GDP in 1995 to 12.2% in 1999 (Table 1). Moreover, the structure of taxation has changed. Direct taxes have nearly doubled, growing from 1.3% to 2.3% of GDP. In absolute terms indirect taxes have grown even more, from 7.6% to 9.9% of GDP. The government has suspended export taxes, which have fallen from 4.6% to 0% of total revenue. Domestic value added tax (TVA) has just kept pace with growth of GDP, while collection of all other indirect taxes have grown more rapidly (Table 1).

Table 1 - Changes in tax burden and tax structure in Madagascar, 1995 to 1999

	1995	1999
Tax revenues as a percent of GDP		
indirect	7.6%	9.9%
direct	1.3%	2.3%
total	8.9%	12.2%
Share of revenues, indirect taxes		
Petroleum duties	8.3%	15.6%
VAT on imports	29.5%	28.6%
Import duties	24.2%	23.7%
Excise and related taxes	4.9%	10.2%
Turnover taxes	3.2%	4.6%
VAT - domestic	25.4%	17.4%
Export duties	4.6%	0.0%

Source: OGT 1995, 1999

How have the poor fared as a result of this significant fiscal reform? Results in Younger, Sahn, Haggblade, and Dorosh (1999) and in Rajemison and Younger (2000) suggest that, these reforms should be reasonably progressive, except for increases in taxes on kerosene. The fact that we now have data before and after the reform allows us to verify those predictions.

Methods[1]

Our main purpose is to calculate the incidence of different taxes in Madagascar. In general terms, a tax transfers real purchasing power from households to the government. The "incidence" of the tax refers to whose real purchasing power falls when the government imposes that tax. Taxes are said to be progressive if poorer households pay a proportionately smaller share of the tax than wealthy households, relative to some measure of overall welfare, usually income or expenditures. Taxes are regressive if the opposite is true, and neutral if the tax shares are equal to overall income/expenditure shares. As in virtually all tax incidence studies in Africa, we use household expenditure (per capita) rather than income as our welfare measure, so that we will concern ourselves with the incidence of taxes across the per capita expenditure distribution.

Assigning Taxes Paid to Households

Previous studies of tax incidence in Africa assign taxes paid based on the observed pattern of demand for taxed goods. In the first study of tax incidence in Madagascar, Younger, Sahn, Haggblade, and Dorosh (1999) – hereafter YSHD – calculate each household's tax paid by multiplying the statutory tax rate times the amount of the good that the household consumes. Alderman and del Ninno make a similar calculation for VAT rates in South Africa. This method is an accurate first-order approximation of the incidence for taxes on final consumption such as a VAT or excise duties on consumer goods like alcohol and cigarettes (Ahmad and Stern, 1991, Sahn and Younger, 2003), but presents clear problems for taxes on intermediate goods. YSHD assume that an import duty on good x raises the price of imported and domestic prices for *final* consumption of good x by the amount of the tax, ignoring any impact of import duties on intermediate products. They make a similar assumption for petroleum imports, although they also make an *ad hoc* attempt to compensate for the indirect effects by including 20 percent of passenger transport services in the petroleum tax base.

In this study, we will take a different approach to taxes that fall heavily on intermediate inputs by making use of an IO table for Madagascar. The general idea is to trace the impact of taxes on intermediate goods through the IO table to final consumers. Thus, some part of petroleum duties falls on passenger transport, and also on most other goods that require transport as an input. We then calculate the incidence of the tax as the sum of the direct and indirect effects of the tax, i.e. we consider both price increases in the product itself and in all other products that use it in their production.

Formally, we use the following model of price formation for domestic production:

$$P_j = \sum_i a_{ij} P_i + \left(1 + t_j^d\right) VA_j + \sum_i \left(1 + t_i^m\right)\left(1 + d_i\right) m_{ij} + s_j P_j \qquad (1)$$

[1] This section draws heavily on Rajemison and Younger, 2000.

where P_j is the price of goods in industry j, a_{ij} is the technical coefficient from the IO table for domestic inputs from industry i to industry j, t_j^d is the VAT rate for domestic value-added in industry j, t_j^m is the VAT rate for imports in industry j, d_j is the import tariff rate for goods in industry j, , a_{ij} is the technical coefficient from the IO table for imported inputs from industry i to industry j, and s_j is the tax rate for various turnover-type taxes on domestic production. We assume that the VAT on imported goods is applied to the post-duty price, which is the practice in Madagascar. We also assume that each good may use different combinations of imported and domestic goods in production, which is consistent with the IO table that we use.
We can write the set of price equations for all industries in matrix form and solve it for a reduced form set of price equations. In matrix notation:

$$P = (I - A - S)^{-1}\left((I + T^d)VA + (I + T^m)M(1 + D)\right) \quad (2)$$

where the unsubscripted variables are matrices corresponding to the variables above. Note that T^d, T^d, and S are all diagonal matrices, with each industry's tax rate on the diagonal. P, VA, and (1+D) are Jx1 vectors, where J is the number of industries in the IO table. All the other matrices are JxJ.

The fact that both A and M enter into the price formation equation implies that the model will capture the indirect effects of taxes on good j on all other goods in the IO table. The model is not, however, a general equilibrium model because it does not account for behavioral responses to tax policy. Any policy change is passed through the IO table mechanically, with fixed technical coefficients. This is consistent with the assumptions of the earlier work in YSHD where all elasticities are assumed to be zero. While a more elaborate model would be preferable, these assumptions provide a first-order approximation of the incidence of small policy changes.

To judge the incidence of a tax, we recalculate prices according to equation (2), but with a vector of zeros substituted for the original taxes in question. The difference between the two price calculations is the tax paid by consumers. Of course, most of the industries in the IO table include imports as well as domestically produced goods. To capture the direct effect of taxes on imports, we simply multiply the tax rate times the amount of imports. We then add these two components together, dividing by total supply of the industry to get a "tax rate". As an example, consider the effect of import duties on the cost of domestic supply:

$$Z = \frac{(P - P_0) + (D - D_0)(I + T^m)M^f}{X} \quad (3)$$

P_0 is the price of domestic production in the absence of import duties, calculated using equation (2). Imposing import duties raises prices of domestic goods to P, and the final impact of the price that consumers pay is the difference between the two. That is the indirect effect. In addition, the direct effect raises the cost of imported final goods by the change in the duty rate, $(D-D_0)$, times the value of imports, increased by the VAT. We then scale this by total supply, X, to get an estimate of the "tax rate" that includes both direct and indirect effects. The calculation for a purely domestic tax, such as the turnover-type taxes, includes only the first term in the numerator.

Input-Output Table Construction

The 1999 expanded IO table has been constructed in parallel with the social accounting matrix (SAM) for 1999 based on the same sources of data. The expanded IO table highlights different product classifications than the SAM in order to emphasize key features of the fiscal regime, notably high rates of taxation on alcohol and tobacco as well as considerable variation within petroleum products – kerosene, consumed largely by poor people as opposed to gasoline, largely consumed by the rich. Data sources and overall aggregates such as GDP and total tax revenues remain the same, although the product-level disaggregation varies.

Value added by product comes from the 1999 national accounts. Rates of intermediate usage are computed from the IO table in Madagascar's detailed national accounts (comptes lourds) of 1995, the last major revision of the IO coefficients in Madagascar. We have applied the a_{ij}/va rates from 1995 to the value added level of 1999 to compute absolute levels of intermediate use. Import data come from the balance of payments while analysis of Customs Office data enables a product-level breakdown. Tax data come from the Ministriy of Finance's Opérations Général du Tresor (OGT). Allocation of certain taxes by product has required more detailed data from the national petroleum company and the industrial census.

Consumption data by income group comes from the 1999 National Household Survey (EPM). The product-level consumption data across household groups, coupled with the indirect tax rates by product, enable us to compute tax incidence of each indirect tax separately.

Comparing the Incidence of Different Taxes

Once we establish the tax rates Z in equation (3), we then apply them to observed consumption of households in the 1999 round of the *Enquete Permanente aupres des Menages* (EPM), a nationally representative household income and expenditure survey. This requires a mapping of each expenditure item in the survey to the industries in the IO table, which we provide in Appendix I. We then compare the incidence of different taxes using concentration curves (Yitzhaki and Slemrod, 1991). Concentration curves are diagrams which are similar to Lorenz curves[2] in that they plot households from the poorest to the wealthiest on the horizontal axis against the cumulative proportion of taxes paid for all households from the poorest up to household n. Yitzhaki and Slemrod prove that for any social welfare function that favors an equitable distribution of income, changing the tax structure by slightly reducing taxes on good x and increasing those on good y by just enough to keep total revenues constant will improve social welfare when x's concentration curve is everywhere below y's. In this case, we say that x dominates y. The intuition is straightforward. If poorer households tend to consume less of a particular good, say gasoline, and more of another, say food, then reducing taxes on the latter and raising those on the former will improve the distribution of welfare. Yitzhaki and Slemrod refer to this as "welfare dominance" because of the analogy with the concept of second order stochastic dominance in the finance literature. The concentration curve for food is above that for

[2] A Lorenz curve plots all households in the sample from poorest to the richest on the horizontal axis vs. cumulative household income (expenditure) as a proportion of all households' total income (expenditure).

gasoline because poorer households account for a larger share of total food consumption than they do for gasoline consumption.

In addition to comparing the concentration curves for different taxes, it is also insightful to compare each tax's concentration curve to two benchmarks: the Lorenz curve for expenditures and the 45 degree line. It is standard in the tax literature to say that a tax is progressive if it falls proportionately less on poorer households and more on wealthy ones, relative to their expenditures, and regressive if it does not. Thus, a tax whose concentration curve is below the Lorenz curve for expenditures is progressive, and vice-versa. As the tax's concentration curve approaches the 45-degree line, it becomes extremely regressive, as in a head tax.

In all cases, we make the comparisons statistically. We use a distribution-free estimator of the standard errors of a set of ordinates on each curve to test the null that the ordinates for each curve are the same (Davidson and Duclos, 1998). Following Howes (1996), we reject the null hypothesis of non-dominance only if the tests at each ordinate differ significantly and are of the same sign. We also reject the null in favor of crossing concentration curves if there are two or more significant t-statistics with opposite signs.

Because the dominance tests are quite general, there are many instances in which we cannot reject the null of no dominance, even though tax incidence might differ for some indices of inequality. To allow for this possibility, we also use another comparison of tax incidence based on extended gini coefficients (Yitzhaki, 1983; Younger, et.al, 1999). In particular, we check for differences in extended ginis for a wide range of parameter values (1.01 to 4, an upper limited suggested by Duclos' (2000) leaky bucket experiments) that allow for increasing weight of poorer households in the underlying social welfare function. If we find that one tax is more concentrated among the poor than another for the entire range of parameter values, we conclude that the second tax "dominates" the first by the e-gini criterion. This not as general a statement as the standard dominance result, because it does not guarantee preference with respect to other social welfare functions. But given the range of parameter values that we use, the results reasonably robust and therefore of interest.

Choosing Tax Rates

We calculate the diagonal elements of T^d as the total domestic VAT revenues per industry divided by the industry's value-added. The diagonal elements of T^m are the total VAT revenues from imports per industry divided by the industry's imports (after duties). The diagonal elements of S are total "taxes on producers" divided by the value of domestic output. (This includes a mixture of property taxes on firms, local market taxes, and some specific excise duties, most importantly on alcohol and tobacco.) Finally, we calculate D as the total value of import duties per industry divided by the total value of imports (cif). Petroleum excises, the *taxe unique sur produits petroliers* (TUPP), are included in this vector, as they are levied only as petroleum products pass through the port. This is the only tax on petroleum products, and we assume that the entire value of this element of D is due to the TUPP. Similarly, but less precisely, we assume that the entire value of producer taxes for the beverage and tobacco industries are excises on those products.

A Caution

While the methods that we use in this paper may seem to be obviously superior to those in YSHD and other similar studies, there is one important caution. The IO table that we use contains only 28 industries, while the expenditure survey has considerable more detail, 119 separate consumption items. Thus, to move from the YSHD approach to the methods we use here, we must aggregate commodities to a considerable extent. Such aggregation will err when the several goods in a category have much different tax rates, because the IO-based analysis must treat all items within an industry as if they had the same rate. We will show an example of this problem in the following section.

Results

Applicable tax rates under different methods

Before considering the incidence results, it is useful to examine the different tax rates that we apply to households' consumption. Table 2 gives the average "actual" rate derived from the national income accounts, and an "effective IO" rate derived from the IO table. The "average actual rate" is the ratio of the total amount of a given tax paid in each industry divided by the total demand (total resources) for that industry. This information comes entirely from the IO table and national income accounts.

Table 2 – Average and Effective Tax Rates, by Industry, Madagascar, 1999

	VAT		Import Duties		Petroleum Excise		Turnover taxes	
Industry	Actual	Effective	Actual	Effective	Actual	Effective	Actual	Effective
Paddy Rice	0.000	0.011	0.000	0.005	0.000	0.003	0.000	0.001
Vanilla	0.000	0.013	0.000	0.004	0.000	0.004	0.000	0.002
Coffee	0.000	0.013	0.000	0.004	0.000	0.004	0.000	0.002
Other Export Crops	0.000	0.012	0.000	0.004	0.000	0.004	0.000	0.002
Industrial Crops	0.000	0.017	0.000	0.006	0.000	0.004	0.000	0.003
Other Crops	0.000	0.011	0.000	0.004	0.000	0.002	0.000	0.001
Livestock	0.000	0.024	0.000	0.007	0.000	0.007	0.000	0.005
Fishing	0.000	0.018	0.000	0.007	0.000	0.013	0.000	0.003
Forestry	0.000	0.019	0.000	0.006	0.000	0.008	0.000	0.003
Mines	0.078	0.101	0.010	0.028	0.000	0.015	0.001	0.004
Energy/Water	0.008	0.114	0.000	0.025	0.000	0.004	0.002	0.005
Gasoline	0.001	0.085	0.000	0.023	0.086	0.084	0.000	0.000
Diesel	0.001	0.028	0.000	0.006	0.131	0.140	0.000	0.001
Crude Petroleum	0.000	0.006	0.000	0.002	0.152	0.162	0.000	0.001
Kerosene	0.000	0.000	0.000	0.000	0.015	0.022	0.000	0.000
Other Petroleum	0.000	0.002	0.000	0.001	0.015	0.022	0.000	0.000
Processed Rice	0.000	0.012	0.005	0.010	0.000	0.003	0.000	0.002
Alcohol	0.012	0.024	0.008	0.011	0.000	0.005	0.000	0.001
Tobacco	0.003	0.034	0.001	0.012	0.000	0.008	0.000	0.005
Other Food Industries	0.010	0.037	0.003	0.015	0.000	0.009	0.007	0.011
Textiles	0.059	0.091	0.020	0.037	0.000	0.010	0.001	0.002
Other Manufacturing	0.062	0.086	0.025	0.039	0.000	0.005	0.007	0.009
Zone Franche	0.007	0.085	0.000	0.034	0.000	0.003	0.000	0.001
BTP	0.003	0.075	0.000	0.034	0.000	0.005	0.001	0.006
Transport & Comm	0.008	0.030	0.014	0.026	0.000	0.005	0.002	0.005
Commercial Margins	0.016	0.033	0.000	0.009	0.000	0.012	0.005	0.006
Other Services	0.015	0.024	0.011	0.017	0.000	0.003	0.004	0.006
Public Administration	0.015	0.027	0.000	0.004	0.000	0.009	0.000	0.003

The "IO effective rate" is the sum of the change in the value of domestic production (by industry) due to a change in the "average actual rate" plus the change in the value of imports due to the tax change, all divided by the total demand for that industry. By the nature of the multiplier calculations, these rates are all larger than the "average actual rates," because they include those rates plus any indirect effects of the tax on other industry through the IO table. Comparison of the average actual with the IO-effective tax rates shows that the latter are much higher, so that the indirect effects of taxes that are passed through the IO table is important. It is also interesting to note that the VAT shows a substantial amount of cascading (noted by comparing the two right columns). This probably is due to the importance of the industries that are exempted, but not zero-rated.[3]

[3] Gottfried and Wiegard (1991) discuss the difference between exemptions, in which an industry does not pay VAT, but does not receive a refund for the VAT already paid by its suppliers, and zero-rating, where the rebates are received. Exemptions are much more common, but they do imply that “exempted” products still include some

Dominance Results - 1999

Table 3 gives the results of the dominance tests for different taxes using our input-output method, and Figure XX has the corresponding concentration curves.[4] None of the taxes is regressive in the sense that its concentration curve is everywhere above the Lorenz curve. However, the concentration curve for taxes on crude oil is significantly above the Lorenz curve over much of the distribution, including the poorest 75 percent of the sample. The reason for this is that taxes on crude petroleum pass through to kerosene (lamp oil), which has a concentration curve that is near the 45-degree line.[5]

Table 3 – Results of Dominance Tests Using Input-Output Method, Madagascar, 1999

Howes' test

Item		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Crude oil, IO	(1)				D	D	D	D	D	D	D
Tobacco	(2)								D	D	D
Household expenditures	(3)							D	D		D
Import duties, IO	(4)					D		D	D		D
VAT, IO	(5)						X		D		D
Turnover taxes, IO	(6)					X			D		D
Diesel, IO	(7)								D		D
Gasoline, IO	(8)										
Alcohol	(9)										
Wages	(10)										

Extended ginis test

Item		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Crude oil, IO	(1)				D	D	D	D	D	D	D
Tobacco	(2)					D	D	D	D	D	D
Household expenditures	(3)				D	D	D	D	D	D	D
Import duties, IO	(4)					D	D	D	D	D	D
VAT, IO	(5)							D	D	D	D
Turnover taxes, IO	(6)								D	D	D
Diesel, IO	(7)								D	D	D
Gasoline, IO	(8)										D
Alcohol	(9)										
Wages	(10)										

Tobacco excises are neutral, with a concentration curve that runs close to the Lorenz curve over almost all of the expenditure distribution. However, as noted in Rajemison and Younger, (2000), there is an important limitation to this calculation. While our IO table includes

taxes. Further, they allow cascading, since purchases from exempted sectors do not include any VAT credit, but there may in fact be some tax included in the costs.

[4] Note that because tobacco and alcohol are only rarely used as inputs, their "average actual" and "average effective" tax rates are (almost) identical. We use only the former in this paper.

[5] Every study of tax incidence in Africa finds that taxes on kerosene are among the most regressive, including YSHD for Madagascar in 1993, and Rajemison and Younger for Madagascar in 1995.

an industry for tobacco, it does not disaggregate between cigarettes, which are taxed and mostly consumed by the better off, and Parakay, which is not taxed and is mostly consumed by the poor. When we aggregate these two products into one industry, the resulting incidence is a combination of the distribution of cigarette and parakay consumption, with the latter diluting the progressive impact of the tobacco excise. In this sense, the simpler product-by-product method of YSHD is superior for evaluating finely defined products that cannot be disaggregated in the input-output table. Not surprisingly, YSHD find a much more progressive distribution of the tax incidence on cigarettes alone, and that is a more accurate assessment of this tax.

The next group of concentration curve includes the VAT, import duties, turnover type sales taxes, and petroleum duties on diesel fuel. These curves are tightly bunched, and somewhat below the Lorenz curve, especially from the middle of the expenditure distribution upwards. While none of these curves dominates the Lorenz curve by the more rigorous Howes' criterion, they all do so by the extended gini criterion. Thus, these main sources of indirect taxation in Madagascar are only mildly progressive. In fact, the differences between these curves and the Lorenz curve are not statistically significant by Howes' criterion. Rather surprisingly, given the close proximity of the curves in the graph, import duties are significantly less progressive than the VAT and diesel excises by Howes' criterion, and also less progressive than turnover taxes by the extended gini criterion.

The next two curves, for gasoline and alcohol excises, are well below the others. Gasoline excises dominate all other taxes except for alcohol excises and wage taxes. The alcohol tax does not dominate most others by the Howes' criterion, mostly because it has larger standard error estimates than the other taxes.[6] However, its concentration curve is always below the others (except for gasoline and wages), and it dominates the other taxes by the extended gini criterion.

Finally, as with most studies, including the two previous studies of Madagascar, direct taxes on (formal sector) wages are highly progressive.

Comparison with Results for 1995

Figures 2 through 6 compare the concentration curves for our input-output method using both expenditure data and an IO table from 1999 with those from Rajemison and Younger (2000), who use 1993 expenditure data and a 1995 IO table. Curves for the 1999 results discussed above are labeled with the tax name and "IO" to indicate that the method considers indirect effects coming through the IO table, e.g. "VAT, IO." Curves for the 1993 expenditure data and 1995 IO table are labeled with the tax name and "1995/1993, e.g. "VAT 1995/1993."

[6] Relatively few households report expenditures on alcohol. As discussed in Sahn and Younger (1998) and Younger et.al. (1999), incidence estimates for "sin" taxes such as alcohol and tobacco excises may be biased by under-reporting of expenditures on these items in the household survey.

Figure 1 – Concentration Curves for Taxes Using Input-Output Method, Madagascar, 1999

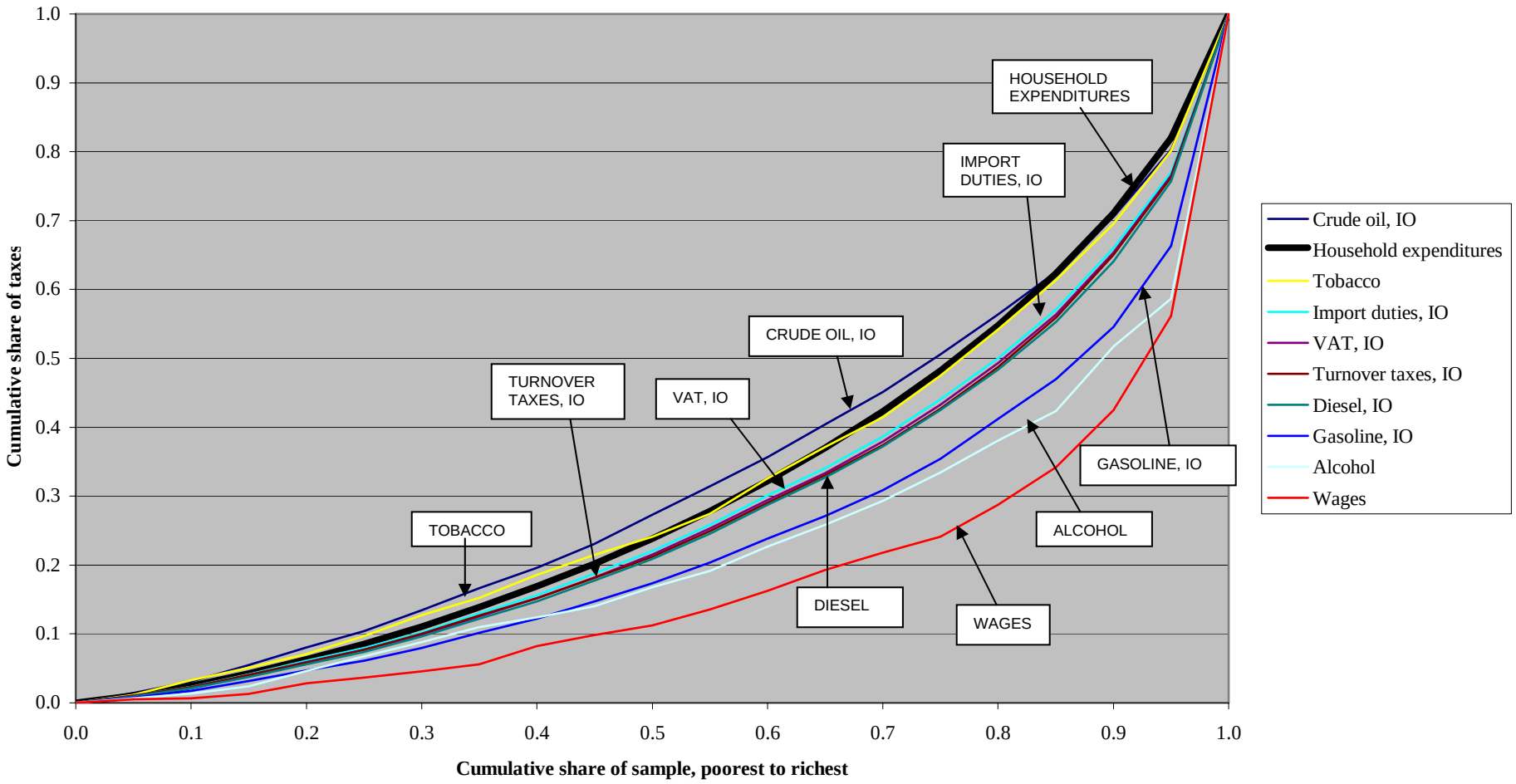


Figure 2 – Comparison of VAT Incidence in 1995/3 and 1999, Madagascar

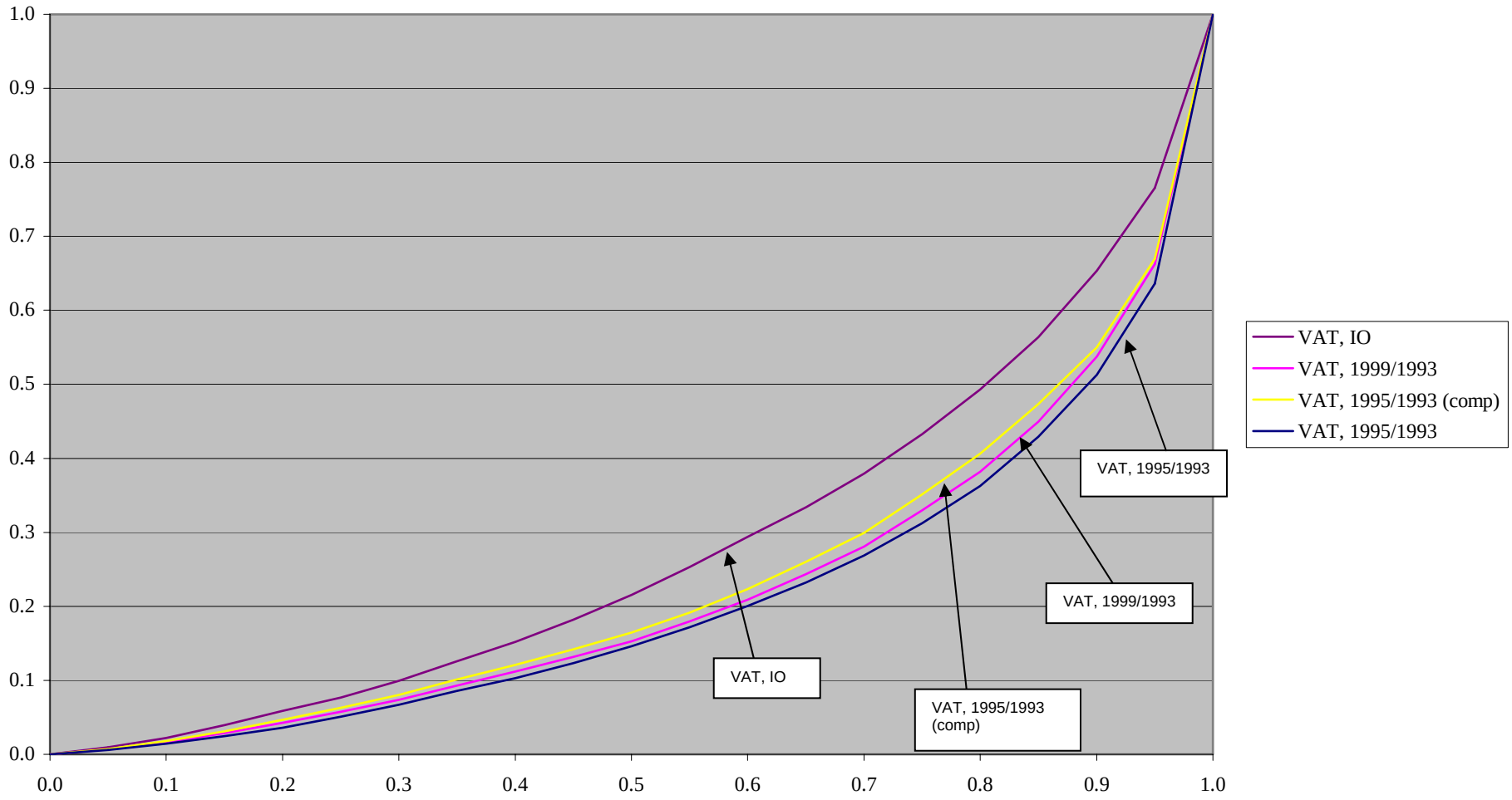


Figure 3 -Comparison of Import Duties Incidence in 1995/3 and 1999, Madagascar

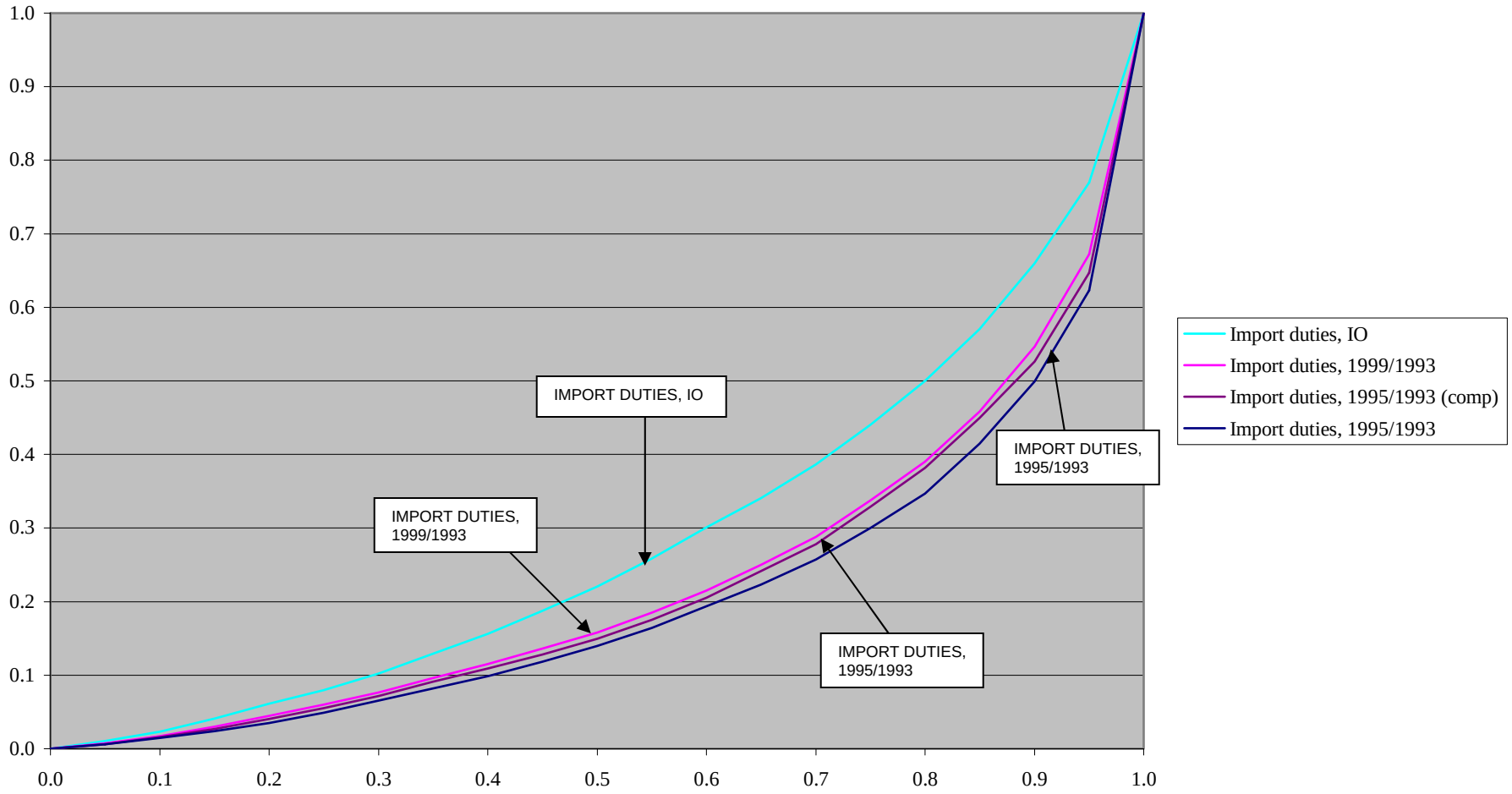


Figure 4 - Comparison of Petroleum Duties Incidence in 1995/3 and 1999, Madagascar

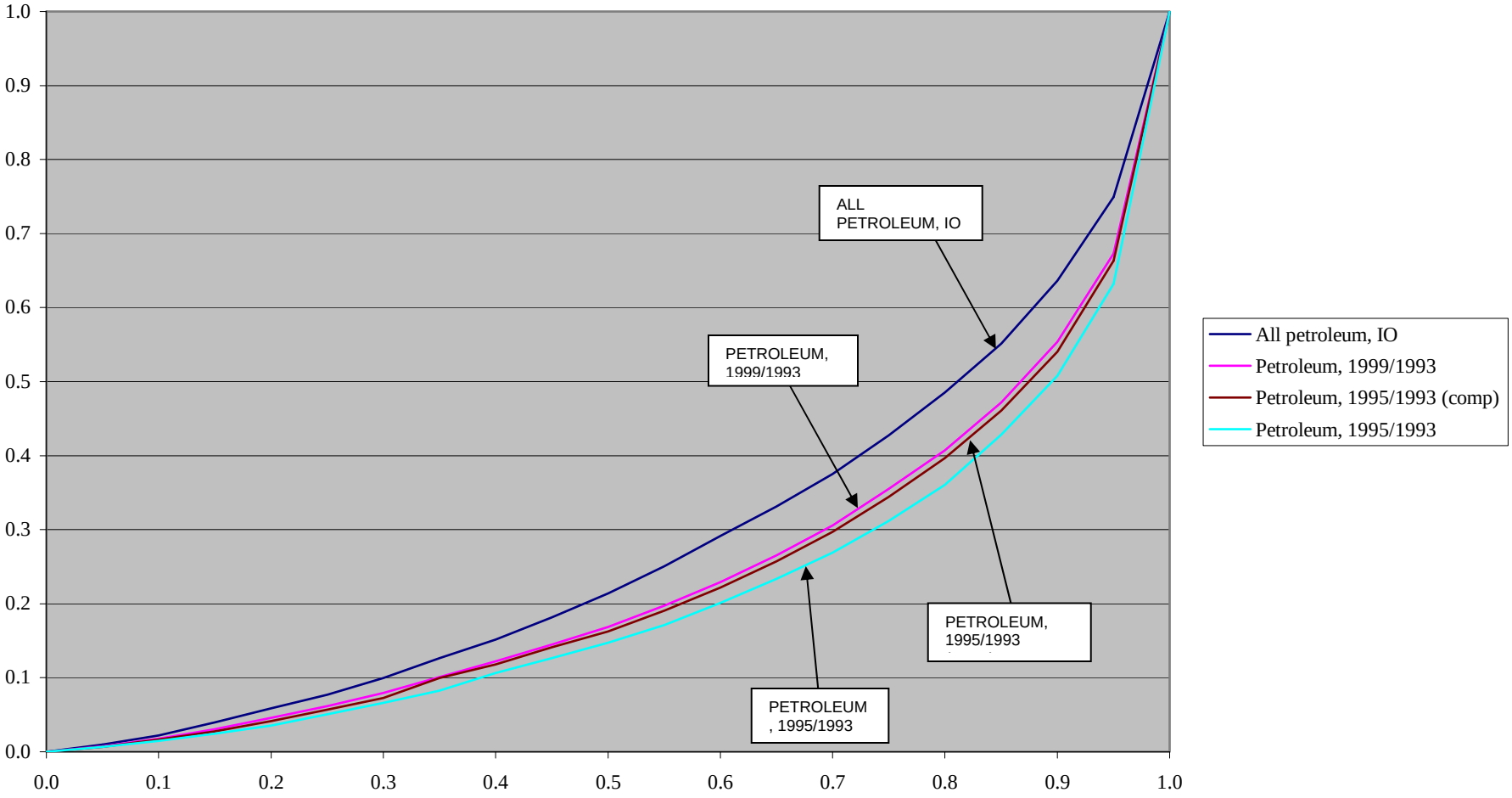


Figure 5 - Comparison of Turnover Tax Incidence in 1995/3 and 1999, Madagascar

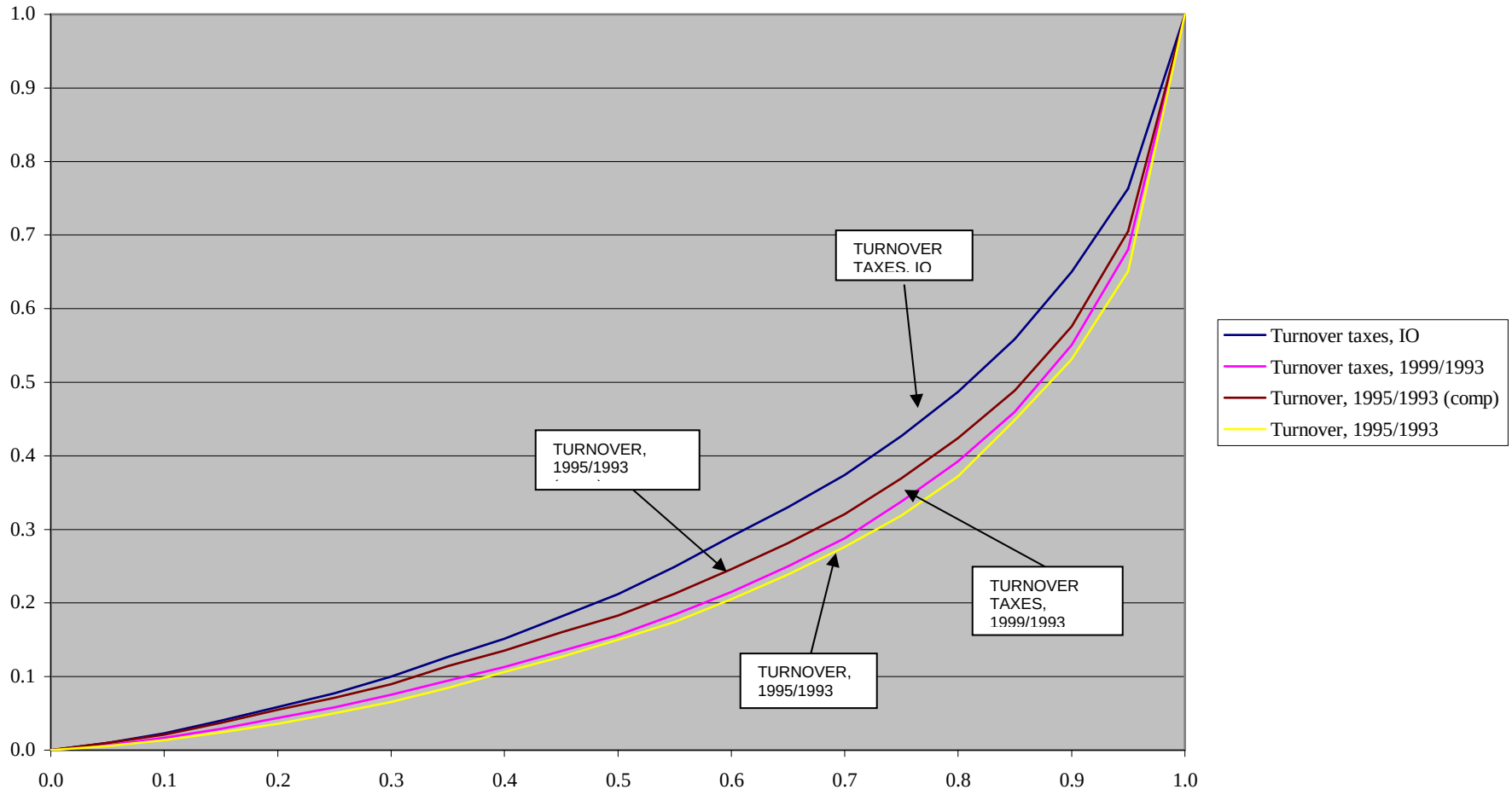


Figure 6 - Comparison of Excise Tax Incidence in 1995/3 and 1999, Madagascar

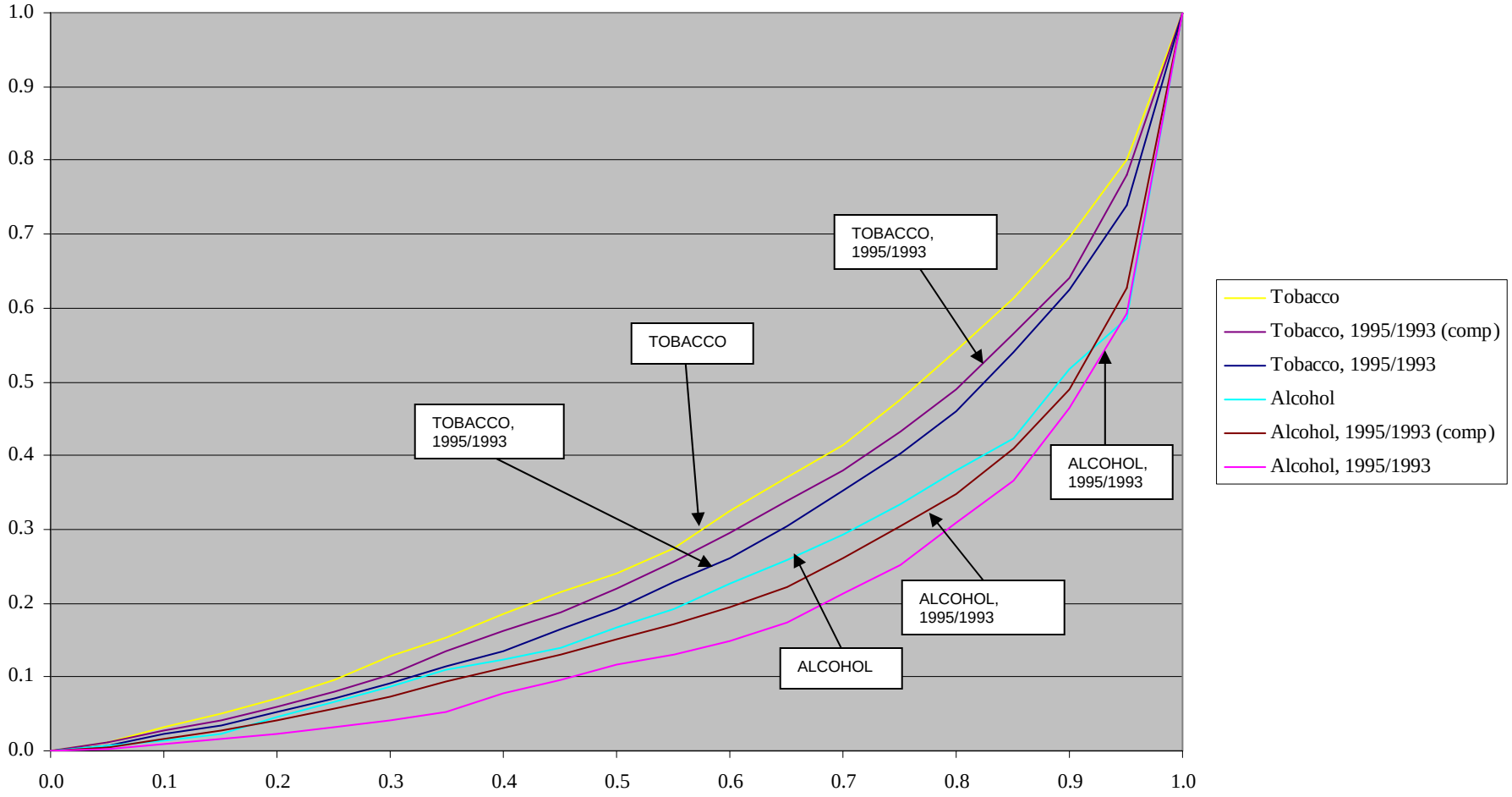
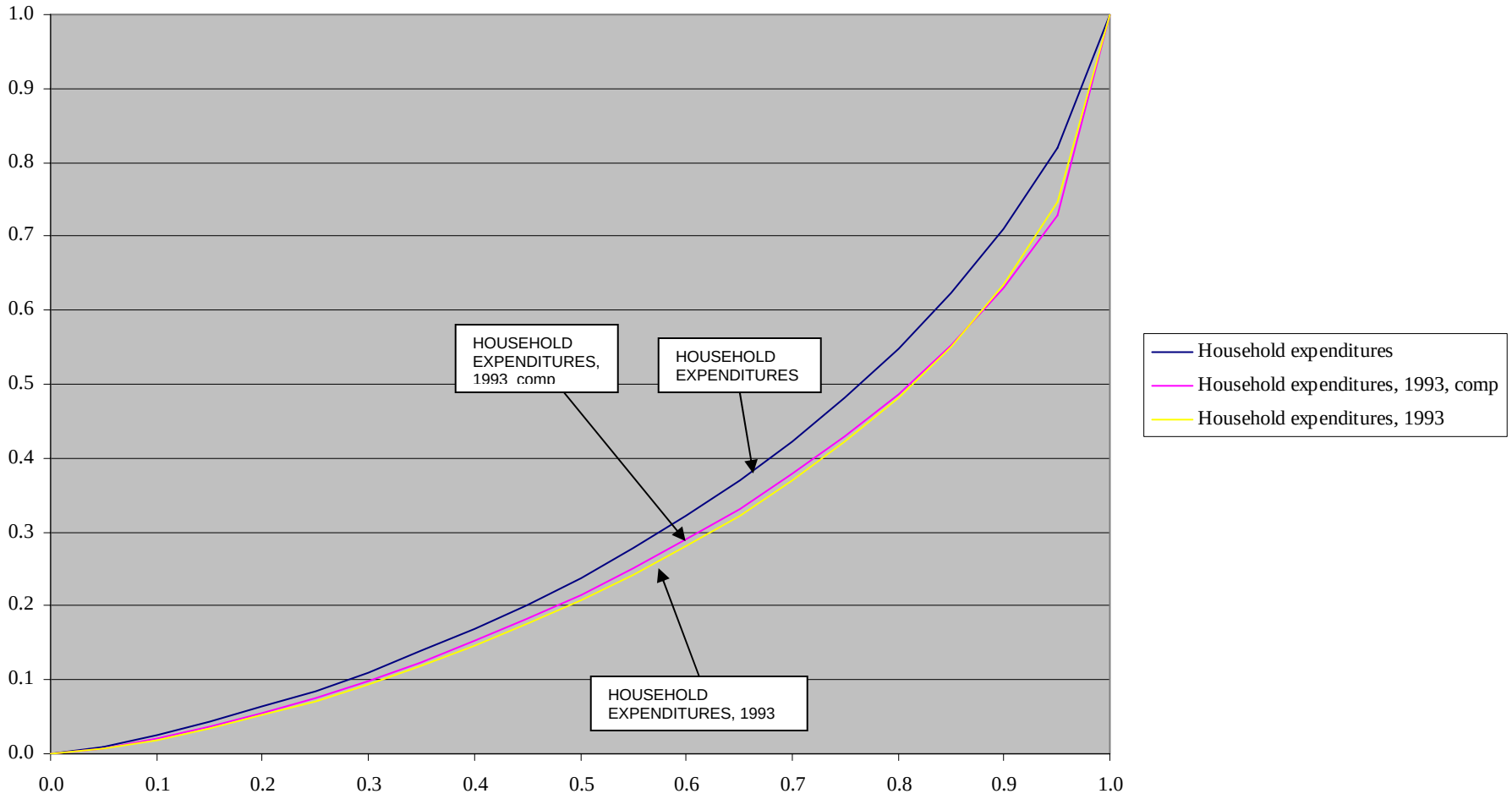


Figure 7 - Comparison of Lorenz Curves in 1995/3 and 1999, Madagascar



It is striking that every concentration curve has shifted up substantially over the 1993/5 to 1999 period. This indicates that the poor are paying a larger share of each tax in 1999 than they did earlier in the decade. To some extent, this reflects the fact that expenditures were more equitably distributed in 1999. But the upward shift of the Lorenz curves (Figure 7) is small relative to the changes in tax incidence.

These changes could be due to any or all of several factors. The most obvious is that tax policy changed significantly between 1995 and 1999, as discussed above. However, changes in tax rates on individual consumption items cannot *directly* cause the shifts that we observe in Figures 2 to 6. The concentration curves reflect shares of taxes paid or, equivalently for *ad valorem* taxes, amount consumed. Changing the tax rate does not change these shares directly because the tax rate cancels out of the numerator and denominator of the shares. Further, for changes in the tax rate to affect the concentration curves indirectly, they would have to change demand differentially across the income distribution. If price elasticities are independent of income, then a tax increase will lead to a proportional decline in demand that is the same for all income levels, so that, again, shares of total consumption (and taxes paid) will remain constant across the income distribution, and the concentration curves will not change.

The only possible way for tax policy changes to affect concentration curves directly is if the tax in question falls on more than one consumption item, as would the VAT or import duties, and if the change in tax rates is not uniform across different consumption items. For example, petroleum duties consist of duties on kerosene, which is consumed in nearly equal amounts in all households, gasoline, which is highly concentrated among the rich, and diesel, which is somewhere in between. If taxes on kerosene rise more than taxes on gasoline, then the overall incidence of petroleum duties would become more regressive, as kerosene would be relatively more important in all petroleum duties after the policy change. As it happens, in simulations that hold both consumption and input-output structure constant at the 1999 values but change tax rates to the 1995 rates, petroleum duties are the only tax whose concentration curve shifts perceptibly (it is slightly more regressive).[7]

In the limit, we can ask "Holding all else constant, did the changes in all tax policy between 1995 and 1999 change the progressivity of the tax system in Madagacar?" Figure 8 addresses that question. Using the pattern of consumption found in the 1999 survey data and the 1999 input-output table, we compare the incidence of all indirect taxes paid using tax rates from 1999 and 1995, respectively. As the graph shows, the incidence of all indirect taxes was virtually identical for the two years' tax systems. Given that the Lorenz curve for total expenditures shifted up significantly (Figure 7), this is an encouraging result.

Figure 8 also shows the incidence of all taxes, indirect and direct, paid by households using 1995 and 1999 rates, but again, holding the structure of consumption and inter-industry trade constant. Here, we see that taxes were somewhat more progressive in 1999 than 1995, a result that is due to the fact that direct taxes (on wages), which are by far the most progressive tax in Madagascar, grew faster than indirect taxes, making the entirety of taxes on households more progressive. Thus, our first important conclusion is that the direct effects of Madagascar's

[7] We do not report these results here, but they are available from the authors upon request.

changes in tax policy in the late 1990s were not regressive. Changes in indirect taxes were roughly neutral, while the increasing share of direct taxes on wages in households' overall tax burden made the system slightly more progressive.

This result is important, but it still leaves us without an explanation for the dramatic shifts in tax incidence found in Figures 2 to 6. We have already alluded to two possible explanations: the pattern of expenditures could have changed such that poorer people now consume larger shares of taxed items, or the structure of production (the IO table) could have changed in such a way that taxes get passed through to final products more likely to be purchased by poorer households.[8]

In addition to these economic explanations, there is a question of data comparability across the 1993 and 1999 EPM surveys. In particular, the survey questionnaire changed from 1993 to 1999, with the 1999 survey asking about considerably fewer specific consumption items, 111 items vs. 206 items in 1993. The surveys also took place in different seasons. It is possible that the different degree of detail and/or the seasonality of the responses led to changes in reported expenditure patterns. Paternostro, Razafindravonona, and Stifel (2001) find that using a household expenditure aggregate for the 1993 data that is strictly comparable to the 1999 aggregate, which involves excluding some of the items found in the 1993 survey, leads to considerable re-ranking of households in the 1999 expenditure distribution. If the re-ranking is such that households buying taxed items tend to fall relative to those that buy less-taxed items, then concentration curves based on the more limited but comparable expenditure variable will appear to be less progressive than those based on the full expenditure aggregate.

Figures 2 through 6 allow us to decompose each of these factors. In addition to the concentration curves from this study and our previous study, discussed above, we include two further curves. The first is labeled with the tax name plus "1995/1993 (comp)". This simulation uses the 1995 IO table and the 1993 EPM survey data, as in our previous study. But in this case, we use expenditure quantiles established by Paternostro, Razafindravonona, and Stifel's household expenditure variable that is comparable to the 1999 expenditure variable. This change has a significant effect on taxes, making each appear less progressive. The effect is especially large for turnover taxes and excises, but much smaller for the VAT, import duties, and petroleum duties.[9] Yet even though the effects are substantial, the resulting concentration curves are still significantly more concentrated among the rich than are the 1999 results.

The second additional curve is labeled with the tax name and "1999/1993." It recalculates the tax incidence for the 1993 EPM using the 1999 IO table and implicit tax rates rather than the 1995 table. It also uses the Paternostro, Razafindravonona, and Stifel household expenditure variable for the 1993 data. Thus, the difference between this curve and the "1995/1993 comp" curve reflects the impact of changes in the input-output structure and changes in the tax structure

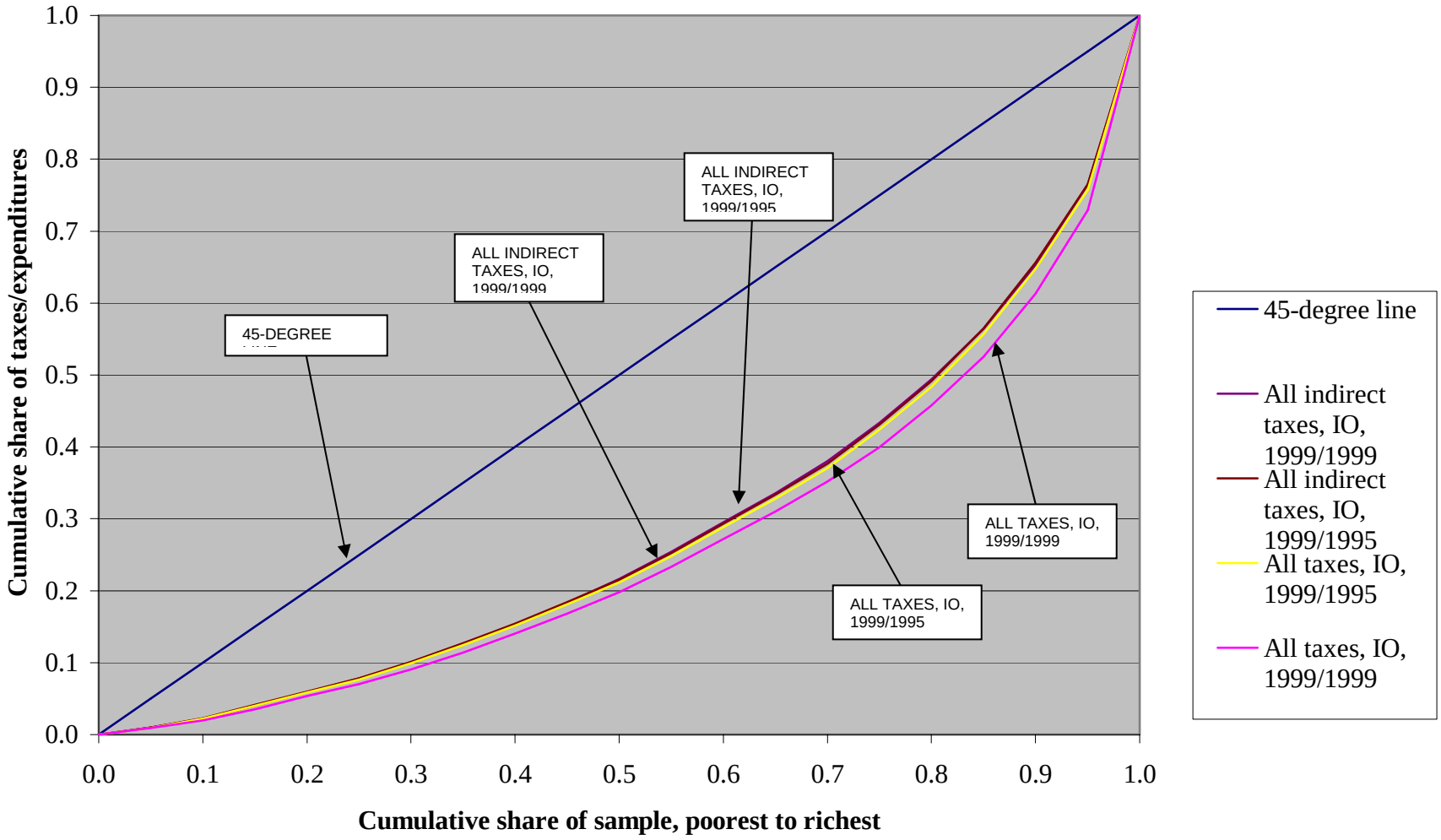
[8] Changes in tax policy could cause either of these structural changes, and so lead indirectly to changes in tax incidence. Because our methods do not model the behavioral responses to changes in tax policy, we cannot comment on whether or not this happened in Madagascar. We consider this point more fully below.

[9] Note that the 1995 IO table did not distinguish different petroleum industries (gasoline, diesel, etc) as the 1999 table does, so the only comparison available between the two tables is for all petroleum products aggregated together.

between 1995 and 1999. The impact of this change is minor in all cases except turnover taxes, where the concentration curve shifts down substantially from the "1995/1993 comp" curve.[10]

[10] Note that we do not simulate changes in the incidence of excise taxes here because they fall almost entirely on final consumption, so that the structure of the IO table does not influence their incidence. The same is true, of course, of the Lorenz curve.

Figure 8 - Comparison of Indirect and All Tax Incidence in 1995/3 and 1999, Madagascar



The remaining difference between the "1999/1993" simulation and the results for 1999 (labeled with the tax name and "IO") is due to changes in the pattern of expenditures. For turnover taxes and excises, this accounts for about half of the difference between our original 1995/1993 results and the new results for 1999. For the VAT, import duties, and petroleum duties, the change in expenditure patterns accounts for almost all of the difference. Overall, then, the main reason that taxes are less progressive in 1999 than then were in 1995/1993 is that expenditure patterns have changed in such a way that poorer households now consume larger shares of taxed items than they did earlier in the decade.

Table 4 reports on changes in consumption patterns between the 1993 and 1999 EPM, by industry in the 1999 IO table. In general, the poorer quintiles have slightly larger shares of all expenditures, which is consistent with the reduction in inequality observed over the period (Paternostro, Razafindravonona, and Stifel, 2001). In some cases, like paddy, the increase in the share for the poorest quintiles is large, but not terribly important because the implicit tax on this industry is small. In others, such as gasoline, alcohol, tobacco, and textiles, the tax rate is high, but the change in expenditure shares is minor. The most important change is in "Other Manufacturing," where the tax rate is relatively high and there is a huge change in the quintile expenditure shares, favoring the poor. "Transport and Communications" and "Other Services" also have large changes in the expenditure shares to the benefit of the poor, although their tax rates are more modest.

In each of these cases, it seems unlikely that the observed changes in tax policy would cause the observed changes in consumption shares. It would have to be the case that, for example, the increase in taxes on "other manufacturing" caused better-off households to shift more strongly out of these goods than poorer households, a result that seems unlikely. A more plausible explanation is that the poor's incomes rose by more than the rich's, leading them to increase their consumption of higher income elasticity goods (like other manufactures) by more than the rich did. This would not be a result of tax policy changes, but of the general economic growth and improved income distribution that Madagascar enjoyed during this period. However, given the problems inherent in the change in the survey questionnaire and in the season if the interviews, it is impossible to be more precise about the possible causes of these changes in consumption patterns.

Table 4 – Quintile Shares of Household Expenditures by Industry, 1993 and 1999

Product/Industry[/1]	Year	Quintile 1	2	3	4	5	Total tax rate[/2]
Paddy	1993	0.097	0.144	0.231	0.223	0.305	
	1999	0.166	0.218	0.258	0.178	0.181	0.018
Other crops	1993	0.079	0.125	0.162	0.234	0.399	
	1999	0.056	0.086	0.143	0.199	0.516	0.027
Livestock	1993	0.029	0.060	0.084	0.167	0.661	
	1999	0.054	0.096	0.153	0.213	0.484	0.040
Fishing	1993	0.032	0.066	0.119	0.233	0.551	
	1999	0.043	0.065	0.118	0.187	0.587	0.036
Forestry	1993	0.012	0.031	0.056	0.190	0.711	
	1999	0.021	0.055	0.129	0.217	0.579	0.031
Energy and water	1993	0.018	0.029	0.044	0.092	0.817	
	1999	0.014	0.030	0.070	0.166	0.720	0.137
Gasoline	1993	0.000	0.000	0.001	0.006	0.993	
	1999	0.000	0.003	0.003	0.060	0.934	0.175
Kerosene (lamp oil)	1993	0.085	0.146	0.175	0.219	0.375	
	1999	0.127	0.161	0.193	0.232	0.287	0.023
Milled rice	1993	0.070	0.135	0.188	0.254	0.353	
	1999	0.092	0.140	0.199	0.228	0.343	0.025
Alcohol	1993	0.035	0.076	0.086	0.158	0.645	
	1999	0.050	0.073	0.103	0.157	0.617	0.318
Tobacco	1993	0.051	0.084	0.126	0.199	0.539	
	1999	0.071	0.115	0.142	0.219	0.453	0.126
Other food industries	1993	0.037	0.074	0.119	0.189	0.582	
	1999	0.054	0.097	0.132	0.201	0.517	0.067
Textiles	1993	0.064	0.111	0.159	0.202	0.463	
	1999	0.062	0.116	0.177	0.222	0.423	0.137
Other manufacturing	1993	0.029	0.056	0.089	0.143	0.684	
	1999	0.066	0.094	0.140	0.200	0.500	0.135
Transport and communication	1993	0.014	0.035	0.066	0.149	0.737	
	1999	0.035	0.070	0.112	0.195	0.588	0.045
Other services	1993	0.027	0.056	0.083	0.152	0.683	
	1999	0.067	0.092	0.133	0.189	0.519	0.035

Note: /1 Industries with no corresponding household expenditure in the 1999 EPM are excluded from this table.

/2 The total tax rate is the implicit rate calculated after tracing all taxes through the IO table, divided by total industry supply. Comparable tax rates are not easily available for 1993 because we do not have an input-output table for the same industry divisions as the 1999 table.

It is interesting that all of the concentration curves have shifted upward more or less in tandem. This implies that the ordering of taxes from most to least progressive in 1999 is very similar to the patterns found in the two previous studies of tax incidence in Madagascar (Younger, et.al, 1999; Harivelo and Younger, 2000). In particular, taxes on kerosene (lamp oil) are the most regressive, followed by a group of VAT, import duties, and turnover taxes, then petroleum duties (other than kerosene), alcohol excises, and finally, direct taxes on wages. The one notable difference is that the 1999 IO table allows us to single out individual petroleum products (gasoline, diesel, and kerosene). This yields the expected results that taxes on gasoline are significantly more progressive than those on diesel, which in turn are significantly more progressive than those on kerosene.

Comparison of Methods

Our earlier study found that using the IO table to include the indirect effects of taxes made little difference to our estimates of their progressivity. Concentration curves were quite similar whether we used the simple methods of YSHD or the input-output method. In this study, however, there are statistically significant differences. In particular, the IO table makes both import duties and the VAT significantly more progressive, i.e., the goods that use products that pay import duties and value-added tax as inputs are more likely to be consumed by better-off households than are the goods themselves. On the other hand, the IO table makes petroleum duties, especially gasoline and diesel, significantly less progressive than they otherwise would be. This is not surprisingly, since gasoline and diesel are consumed as final products only by the highest income households. But they are also inputs into goods that many other households consume. It is worth noting, however, that even though accounting for the indirect effects of these taxes makes them seem less progressive, they remain among the most progressive taxes in Madagascar (Tables 5 and 6), comparable to excise duties on alcohol and income taxes on formal sector wages.

Table 5 – Results of Dominance Tests Using Input-Output and Simple Average Methods, Madagascar, 1999 (Howes' Criterion)

Item and method		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
45-degree line	(1)		D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Kerosene, Simulated	(2)			D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Crude oil, IO	(3)						D	D	D	D	D	D	D	D	D	D	D	D	D	D
Tobacco	(4)															D	D		D	D
Household expenditures	(5)													D		D			D	D
Import duties, Average	(6)								D	D	D	D		D		D			D	D
VAT, Average	(7)								D	D		D		D		D			D	D
Import duties, IO	(8)									D				D		D			D	D
VAT, IO	(9)										X		X			D			D	D
Turnover taxes, IO	(10)									X			X			D			D	D
All petroleum, IO	(11)															D			D	D
Turnover taxes, Average	(12)									X	X					D			D	D
Diesel, IO	(13)															D			D	D
Excises	(14)																D			D
Gasoline, IO	(15)																	X		D
Alcohol	(16)																			D
All petroleum, Average	(17)															X				D
Wages	(18)																			D
Gasoline, Average	(19)																			

Table 6 – Results of Dominance Tests Using Input-Output and Simple Average Methods, Madagascar, 1999 (E-gini Criterion)

Item and method		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
45-degree line	(1)		D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Kerosene, Simulated	(2)			D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Crude oil, IO	(3)						D	D	D	D	D	D	D	D	D	D	D	D	D	D
Tobacco	(4)									D	D	D	D	D	D	D	D	D	D	D
Household expenditures	(5)							D	D	D	D	D	D	D	D	D	D	D	D	D
Import duties, Average	(6)								D	D	D	D	D	D	D	D	D	D	D	D
VAT, Average	(7)								D	D	D	D	D	D	D	D	D	D	D	D
Import duties, IO	(8)									D	D	D	D	D		D	D	D	D	D
VAT, IO	(9)													D		D	D	D	D	D
Turnover taxes, IO	(10)															D	D		D	D
All petroleum, IO	(11)															D	D	D	D	D
Turnover taxes, Average	(12)															D	D		D	D
Diesel, IO	(13)															D	D		D	D
Excises	(14)																D		D	D
Gasoline, IO	(15)																		D	D
Alcohol	(16)																			D
All petroleum, Average	(17)																			D
Wages	(18)																			D
Gasoline, Average	(19)																			

Conclusions

Madagascar implemented significant tax reforms in the 1990s. Using simulations to hold the structure of consumption and inter-industry trade constant, we find that, overall, taxes were somewhat more progressive in 1999 than 1995, a result that is due to the fact that direct taxes (on wages), which are by far the most progressive tax in Madagascar, grew faster than indirect taxes, making the entirety of taxes on households more progressive. Thus, our first important conclusion is that the direct effects of Madagascar's changes in tax policy in the late 1990s were not regressive. Changes in indirect taxes were roughly neutral, while the increasing share of direct taxes on wages in households' overall tax burden made the system slightly more progressive. The one major tax change that was regressive was the increase in taxes on kerosene, a product with a very low income elasticity of demand.

Despite this conclusion, the burden of taxation did shift toward the poor in Madagscar between 1995 and 1999. This was not due to tax policy changes, but rather, to changes in consumption patterns. Unfortunately, significant changes in survey design and timing cast doubt on the comparability of expenditure data over time, making any conclusion regarding changes in consumption patterns over time tentative. But our best guess is that poorer households significantly increased their share in wage income and in the consumption of products that are more heavily taxed. In part, this reflects the general increase in incomes that Madagscar experienced in the late 1990s, especially the poor. As income rises, consumption shares for lightly taxed food items decline, and those for other, more heavily taxed goods, increase. What we see, then, is the poor gradually moving into the formal sector of the economy (as consumers, mostly), which is a good thing, but one that brings with it a higher relative tax burden for the poor.

In terms of methods, we have found that using the input-output table to map taxes on intermediate inputs to final consumers makes a significant difference in our analysis of tax incidence. In particular, petroleum duties, especially those on gasoline and diesel, are significantly less progressive than the pattern of final consumption suggests. This is not surprisingly, since gasoline and diesel are consumed as final products only by the highest income households. But they are also inputs into goods that many other households consume. Nevertheless, taxes on gasoline and diesel (but not kerosene) remain among the most progressive taxes in Madagascar, even after accounting for the indirect effects on the prices of goods that use these products as intermediate inputs. In addition to these on the estimated incidence of petroleum duties, using the input-output table makes both import duties and the VAT significantly *more* progressive, i.e., the goods that use products that pay import duties and value-added tax as inputs are more likely to be consumed by better-off households than are the goods themselves.

Even though our more sophisticated methods change the estimated incidence of individual taxes, the ordering of taxes from least to most progressive that we find here for 1999 is quite similar to that in YSHD. Taxes on kerosene, and those on crude oil to the extent that they pass through to kerosene, are at best neutral, and are regressive over much of the income distribution. The incidence of the VAT, import duties, turnover type sales taxes, and petroleum duties on diesel fuel are all quite similar, and mildly progressive. Gasoline and alcohol excises

are significantly more progressive than the other indirect taxes. And, as with most studies, including the two previous studies of Madagascar, direct taxes on (formal sector) wages are highly progressive.

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Appendix I

Input-Output Table Industry Assignments for Products in the *ECM*

Expenditure Item	IO Table Industry
Adults' clothing	Textiles et de Confection
Children's clothing	Textiles et de Confection
Underwear	Textiles et de Confection
Cloth for clothing	Textiles et de Confection
Accessories	Textiles et de Confection
Other clothing	Textiles et de Confection
Sewing materials	Textiles et de Confection
Adults' shoes	Textiles et de Confection
Children's shoes	Textiles et de Confection
Electricity	Eléctriques
Water	Energie
Kerosene 4/	Energie
Natural gas	Energie
Candles	Chimiques
Furniture	Du Bois
Household accessories	Diverses et du Cuir
Household linen	Textiles et de Confection
House furnishings	Diverses et du Cuir
Household appliances	Diverses et du Cuir
Kitchen appliances	Diverses et du Cuir
Cooking appliances	Diverses et du Cuir
Glassware	Diverses et du Cuir
Kitchen utensils	Diverses et du Cuir
Household utensils	Diverses et du Cuir
Home maintenance products	Services aux particuliers
Home maintenance tools	Diverses et du Cuir
Other home maintenance	Services aux particuliers
Sports and cultural events	Services aux particuliers
Hotels, vacations	Services aux particuliers
Radios and VCRs	Diverses et du Cuir
Cameras	Diverses et du Cuir
Sports equipment	Diverses et du Cuir
Other durable equipment and repairs	Services aux particuliers
Books, magazines, and newspapers	Du Papier et Edition
Leisure accessories	Diverses et du Cuir
Medicine	Chimiques
Personal care articles	Diverses et du Cuir
Automobile	Métal et mécaniques
Motorcycle	Métal et mécaniques
Bicycles	Métal et mécaniques
Gasoline and lubricants	Energie
Transportation in cities	
Inter-city transportation	
Mail and telecommunications	Services aux particuliers
Watches	Diverses et du Cuir
Jewelry	Extractives
Education and training fees	Services aux particuliers
All foods except those listed below:	Agriculture ou Elevage
Milled Rice	Agriculture
Rice flour	Agriculture
Wheat	Agriculture
Other cereals	Agriculture
Cheese	Elevage
Other dairy products	Elevage

Peanut oil	Alimentaire
Coconut oil	Alimentaire
Soybean oil	Alimentaire
Butter	Alimentaire
Margarine	Alimentaire
Lard	Des Corps gras
Marinated or salted vegetables	Alimentaire
Other canned vegetables	Alimentaire
Jams and jellies	Alimentaire
Canned fruits	Alimentaire
Canned meats	Alimentaire
Canned fish	Alimentaire
Other canned food	Alimentaire
Condensed or powdered milk	Alimentaire
Baby food	Alimentaire
Fruit juice	Des Boissons
Syrup/Soda	Des Boissons
Bottled water	Des Boissons
Meals in restaurants	Services aux particuliers
Rum	Des Boissons
Beer	Des Boissons
Wine & Liquor	Des Boissons
Cigaret detes	Du Tabac
Parakay	Du Tabac
Chairs	Du Bois
Tables	Du Bois
Beds	Du Bois
Other furniture	Du Bois
Sewing machine	Diverses et du Cuir
Gas stove	Diverses et du Cuir
Refrigerator	Diverses et du Cuir
Television	Diverses et du Cuir